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Extended Abstracts

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title: **Simulation of phosphorus transport in an unconfined aquifer: a case study**

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INTRODUCTION

Intensifying loading of nutrient into water reservoir such as pond and groundwater reservoir is an important environmental issue (Liu et al., 2008; Smil, 2000). Phosphorus is one of inorganic nutrients that is released widely by human through activities and may cause eutrophication with adverse effect on ocean water and fresh water (Hauer, 2006; Smil, 2000; Liu, 2008; Khan, Ansari, 2005). In Malaysia many plants, including oil palms, which are the primary crops in many areas, are notable to grow to maturity without application of phosphorus fertilizers due to deficiency of soil nutrients. Ninety percent of phosphorus in oil palm is derived from fertilizers (Zaharah et al., 1997).The Malaysian government imited the concentration of phosphorus in groundwater for class IIA/IIB and III as 0.1 mg/l and 0.2 mg/l respectively (DOE, 2004).

Since shallow lakes are almost always hydraulically connected to aquifer systems (Rahim et al., 2006), the interaction between surface subsurface water is a key feature in migration of pollutant from one to another. This interaction can be simulated by those computer softwares which are able to model either Navier-Stoks (de Lemos 2006) or the extended Darcy's (Todd and Mays 2005) equations. US Corps of Engineers recommended the later which is broadly used around the world with success (USCE 1999).

METHODOLOGY

In the present study, an area of 16.03 hectares inside the campus of University Putra Malaysia, Serdang, Selangor, Malaysia with annual average rainfall of 2990 millimeters, where a sludge pit and a pond are located at the same site, was chosen as the study area. The top layer of the aquifer, 10 meters thick Kajang formation, consists of clay loam while the lower layer is recognized as Kuala Lumpur limestone formation (Saghravani, 2009; Gobbett & Hutchiston, 1973; Huat et al., 2004). The soil was profiled as two layers, Layer 1 with less and underneath layer, Layer 2 with higher hydraulic conductivity. The required data and parameters for simulations were collected between January, 2007 and March, 2008 (Saghravani, 2009).Visual MODFLOW package which includes MODFLOW (Harbaugh, 2005) and MT3DMS (Zheng, 2006) was selected to find the patterns of groundwater flow for the case the groundwater level dropped two meters inside the pond was simulated. The model was run to simulate the flow in 3650 and 18250 days. These long periods were chosen due to low hydraulic conductivity of Layer No.1 and also slow phosphorus movement in soil.

RESULTS AND DISCUSSION

Transient regime was considered to simulate the transportation of contamination in the flow for both periods. The flow direction of groundwater was observed to be toward the pond due to the placement of boundary. In this case the water level dropped 2 meters in the pond. This causes change in groundwater flow direction and water from other parts of study area, including the sludge area. The simulation results show that the phosphorus does not spread in the first layer that is consisting of clay loam with low hydraulic conductivity. Figures 1, 2, 3 and 4 show the directions of phosphorus movement in 10 and 50 years respectively. In 18250-days, the maximum concentration of phosphorus in Layers No.1 and 2 were calculated at 0.55 mg/l and 0.35 mg/l respectively. One can conclude that vertical migration can be responsible for the occurrence of phosphorus within the second layer because the direct horizontal movement of pollutant through the first layer to the pond is limited due to its very low hydraulic conductivity.

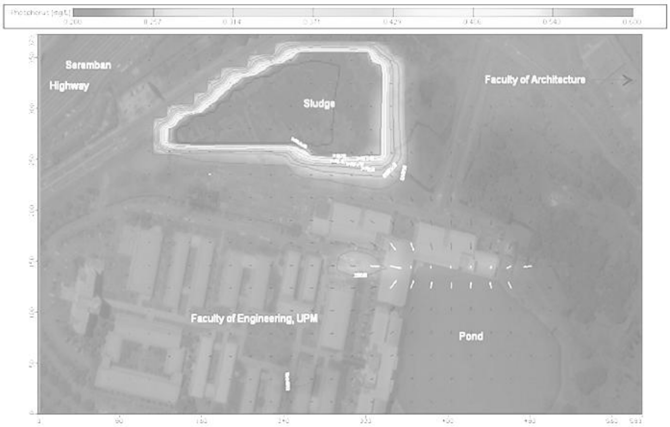

Figure 1. Phosphorus concentration in layer No.1 (3650 days).

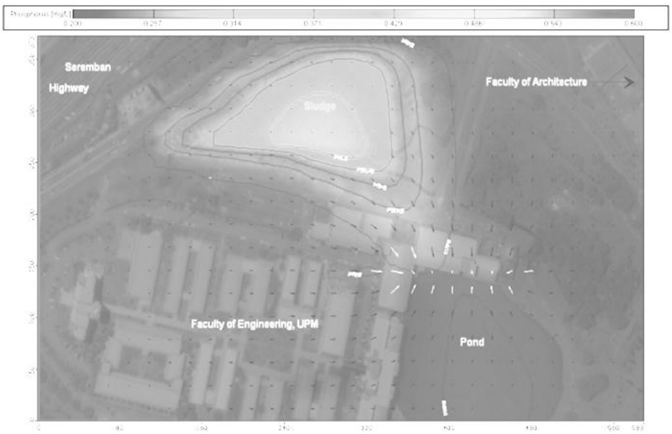

Figure 2. Phosphorus concentration in layer No.1 (3650 days).

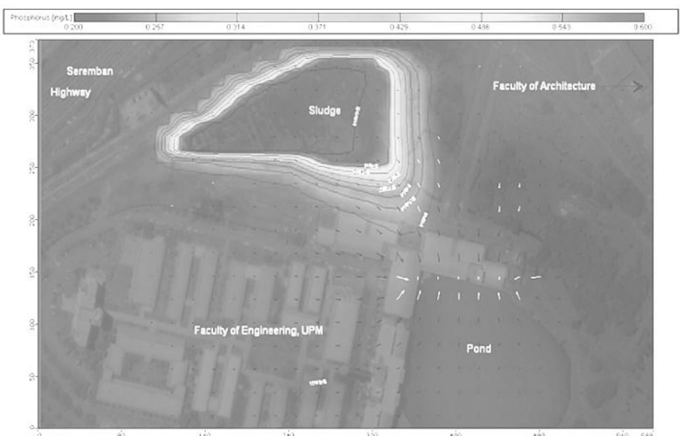

Figure 3. Phosphorus concentration in layer No.2 (18250 days).

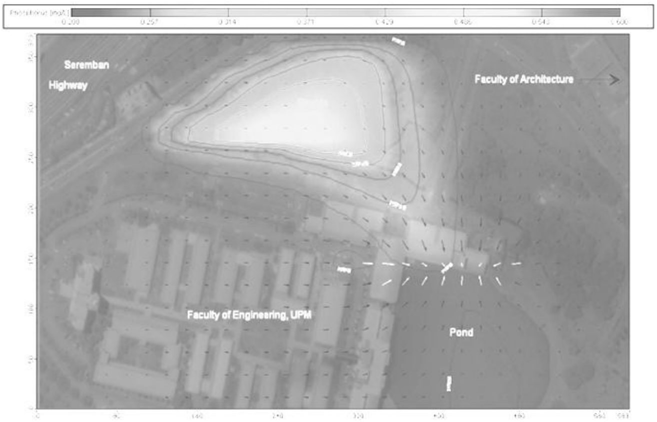

Figure 4. Phosphorus concentration in layer No.2 (18250 days).

CONCLUSION

Visual MODFLOW can be employed used to model groundwater movement and MT3DMS is able to find the fate of leached phosphorus from the sludge into the subsurface. The combination of these two was used to predict and estimate the conditions and concentration of contamination and assess water quality. The results show that along with the reduction of the water level in the pond, the direction of local groundwater can be changed from Northeast-Southwest to be toward the pond and increase in phosphorus concentration. As a result, the use of fertilizers should be reduced to control the concentration of phosphorus in groundwater. Further studies should be implemented to assess and control the source of contamination and water quality in future.

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